भारतीय मानक
Indian Standard

IS 4591 (Part 2) : 2022

स्वचलित सीढ़ियाँ एवम चलपथ

भाग 2 अनुरक्षण के लिए मार्गदर्शिका

Escalators and Moving Walks

Part 2 Guide for Maintenance

ICS 91.140.90

© BIS 2022

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in www.standardsbis.in

March 2022 **Price Group 5**

Lifts, Escalators and Moving Walks Sectional Committee, ETD 25

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards after the draft finalized by the Lifts, Escalators and Moving Walks Sectional committee was approved by the Electrotechnical Division Council.

With ageing population and growth of vertical cities, the installation of escalators and moving walks are multiplying multifold year on year. Every minute of every day, people are using escalators and moving walks. In shopping centres, department stores, cinemas, airports, train stations and a host of other buildings, they are quietly, efficiently, safely and unobtrusively transporting large numbers of people.

The maintenance of escalators and moving walks is of utmost importance as:

a) these installations are used intensively, all over the year;
b) operating conditions vary widely throughout a typical day: rush hours followed by periods of downtime; and
c) equipments suffer from corrosion and deterioration: winter conditions, sea air, sand, dust, pollution, and so on.

The key to their smooth and successful operation is efficient planning, installation and quality maintenance.

The objective of this standard is to provide the maintenance requirements for electric escalators and moving walks that carry passengers. Only correct and preventive maintenance performed by a competent maintenance person in conformity with the maintenance instructions can ensure the safe and intended functioning of an installation.

In this standard it is assumed that the installation to be maintained has already been installed in the market.

The composition of the Committee, responsible for the formulation of this standard is given at Annex C.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ESCALATORS AND MOVING WALKS

PART 2 GUIDE FOR MAINTENANCE

1 SCOPE

This standard is applicable for all new installed escalators and moving walks (pallet or belt type) as defined in **3** of IS 4591 (Part 1/Sec 1 to 3).

This standard specifies the elements necessary for the preparation of the instructions for the maintenance operations, as in **3.1**, which are provided for new installed escalators and moving walks.

This standard does not cover instructions for the installation and the dismantling.

Existing installations are not covered by this standard.

2 REFERENCES

The standards listed below contain provisions, which, through reference in the text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated:

IS No.	*Title*
4591 (Part 1/Sec 1 to 3) : 2020	Escalators and moving walks: Part 1/Sec 1 Safety requirements Part 1/Sec 2 Guide for planning and selection Part 1/Sec 3 Inspection and test (*first revision*)
16449 (Part 1) : 2018	Graphical symbols — Safety colors and safety signs: Part 1 Design principles for safety signs and safety markings
16451 : 2018	Graphical symbols — Safety colors and safety signs — Registered safety signs
IS/ISO 9001 : 2015	Quality management systems — Requirements (*fourth revision*)

3 TERMS AND DEFINITIONS - SYMBOLS AND ABBREVIATIONS

For the purpose of this standard, the definitions in all the standards referred in **2** above and the following apply:

3.1 Maintenance — All the necessary operations to ensure the safe and intended functioning of the installation and its components after the completion of the installation and throughout its life cycle.

3.1.1 Maintenance includes:

a) lubrication, cleaning etc.

However, cleaning of the external parts of the escalator or moving walk cannot be considered as maintenance:

b) checks;

c) passenger rescue operations;

d) the operations of setting and adjustment; and

e) repair or changing of components which may occur due to wear and tear and do not affect the characteristics of the installation.

3.1.2 The following are not considered as maintenance operations:

a) changing of major component, such as the machine, even if the characteristics of the new component are the same as the original;

b) replacement of installation;

c) modernization of the installation including changing of any characteristics of the installation (such as load, speed etc.); and

d) rescue operation carried out by fire brigade.

3.2 Maintenance Organization — Company or part of company where competent maintenance person(s) carry out maintenance operation on behalf of the owner of the installation.

3.3 Competent Maintenance Person — Designated person, suitably trained, qualified by knowledge and practical experience, provided with necessary instructions and supported within their maintenance organization to enable the required maintenance operations to be safely carried out.

3.4 Manufacturer — Person who takes responsibility for the design, manufacture and placing on the market the machinery of escalators or moving walks.

3.5 Installer — Person who takes responsibility for the design, manufacture, installation and placing on the market of escalator/moving walk.

3.6 Installation — Completely installed escalator or moving walk.

3.7 Owner of the Installation — Person who has the power of disposal of the installation and/or takes the responsibility for its operation and use.

4 ELABORATION OF MAINTENANCE INSTRUCTIONS

4.1 General

The installation covered by this Indian standard shall be maintained in good working order in accordance with the installer's instructions. To this effect, regular maintenance of the installation shall be carried out to ensure, in particular, the safety of the installation and of those using the installation. The safety of an installation shall take into account the ability to be maintained without causing injury or damage to health.

Regular maintenance of the installation shall be carried out to ensure the reliability of the installation.

The access and the associated environment shall be maintained in good working order in accordance with the installer's instructions.

The instructions for maintenance of an installation shall be provided by the installer as defined in **3.5**, after completion of the installation as a result of a risk assessment.

The instructions for maintenance of an installation shall be provided by the manufacturer, as defined in **3.4**, when placed on the market, and be the result of a rise assessment.

In order that the aim of the maintenance instructions can be achieved, they shall be formulated so that they can be clearly and easily understood by competent maintenance person.

The competent maintenance person within the maintenance organization shall be continuously updated.

NOTE — The owner of the installation should be informed that the qualification of the maintenance organization is in conformity with the regulation applicable in the country/state in which the installation operates. If no such regulation exists, the qualification can be ensured by the certified quality system in accordance with IS/ISO 9001 supplemented if necessary to take into account the specific features of the installation.

The installer/manufacturer shall provide maintenance instructions intended for the owner of the installation (*see* **4.3.2**) including the information intended for the maintenance organization (*see* **4.3.3**).

4.2 Elements to be taken into Account for Maintenance Instructions

When preparing the content of the maintenance instructions (*see* **4.3** and **5**) the following elements shall be taken into account:

a) The specifications and the intend use of the installation (type of installation, performance, etc);
b) The environment in which the installation and its components are installed (weather conditions, vandalism etc);
c) Any restriction of use;
d) The result of risk assessment (*see* **5**) for every working area and for every task undertaken;
e) The specific maintenance instructions provided by the manufacturer of safety components; and
f) In case of components other than safety components, where maintenance is necessary, the maintenance instructions provided by the manufacturer of these components.

4.3 Information to be included in the Maintenance Instructions

4.3.1 *General*

The maintenance instructions shall contain information relating to the tasks of the owner and respectively the maintenance organization.

4.3.2 *Information to the Owner of the Installation*

The information relating to the tasks of the owner of the installation shall include the following:

4.3.2.1 The need for the owner to keep the installation in a safe operating condition. To fulfill this, the owner shall use a maintenance organization complying with the requirements of the Standard.

NOTE — It is recommended to inform the owner of the installation about the need to use a maintenance organization with adequate and proper insurance cover provided by an insurance company.

4.3.2.2 The need for the owner to take care of any State/National regulations and other requirements, where relevant, and their implications on maintenance.

4.3.2.3 The need for planned maintenance to be carried out by a maintenance organization, at the latest when the installation is put into service or if the installation is to remain unused for a long period of time before first being put into service.

4.3.2.4 The importance for the owner of the installation to have the same maintenance organization in the case of several installations having common well/spaces and/or machine room.

4.3.2.5 The need for the owner to put the installation out of service in case of dangerous situations.

4.3.2.6 The need for the owner of the installation to inform the maintenance organization:

a) immediately about any perceived abnormal operation of the installation or abnormal change in its direct environment;

b) immediately after putting the installation out of service in the case of a dangerous situation;

c) after any rescue intervention by their authorized and instructed person(s);

d) before any modification related to the installation and/or its environment or use;

NOTE — The owner of the installation should obtain from the company carrying out the relevant modification the maintenance instructions for the maintenance organization.

e) before any authorized third-party inspection or works other than maintenance works are carried out on the installation;

f) before taking the installation out of service for a prolonged period of time; and

g) before putting the installation back into service after a prolonged period of non operating time.

4.3.2.7 The need for the owner of the installation to take into consideration the consequences of the risk assessment carried out by the maintenance organization (*see* **4.3.3.4** and **5.1**).

4.3.2.8 The need for the owner of the installation to make sure that the risk assessment for maintenance is carried out:

a) if the maintenance organization is replaced;

b) if the use of the building and/or the installation changes;

c) after a major modification of the installation or of the building; and

d) if it is the case, after an accident involving the installation.

4.3.2.9 The need for the building owner to ensure, through a risk assessment, that:

a) their premises are safe and free from risk to health as far as is practicable. This includes access to the premises and installation equipment, and articles or substances used according to the regulation for the use of work equipment at the workplace;

b) the persons using the premises are informed about any remaining risks; and

c) any action to be done as a consequence of his risk assessment is carried out.

Regarding the access ways to areas reserved to maintenance persons, the need for the owner of the installation to inform the maintenance organization, in particular about:

1) the access ways to be used and fire evacuating procedures from the building;

2) the place where the keys of the reserved areas can be found;

3) if necessary, the persons who shall accompany the maintenance persons to the installation; and

4) if necessary, personal protective equipment to be used in the access ways, and, possibly, where this equipment can be found.

The information shall be made available also on site to the maintenance organization.

4.3.2.10 The need for the owner of the installation to ensure that the name and the telephone number of the maintenance organization are always available to the user of the installation, permanently affixed and clearly visible.

4.3.2.11 The need for the owner of the installation to ensure that the keys of machine room doors (trap doors) and of inspection and emergency doors (trap doors), if any, are permanently available in the building and are used only by persons authorized to gain access.

4.3.2.12 The need for the owner of the installation to provide, in all circumstances, safe access to the building and to the installation for the maintenance organization involved in the rescue of persons.

4.3.2.13 The need for the owner of the installation to keep the access to working areas and working rooms safe and free for the maintenance persons and to inform the maintenance organization about any hazard or change in the workplace and/or the access ways (lighting, obstructions, ground conditions, etc.).

4.3.2.14 In addition to those examinations and tests which the owner of the installation entrusts to the maintenance organization, the need for the owner to carry out periodically, in their own interests, the following:

A full travel in both directions, when they exist, to assess any changes in the quality of the ride or damage to the equipment.

Typical items to be checked to ensure that they are in place, undamaged and functioning correctly are:

a) all lighting and indicators;

b) emergency stopping device;

c) hand rails;

d) skirting/deflector devices;

e) combs;

f) safety signs/pictograms;

g) approximation of speed between handrail and steps/pallets;

h) steps/pallets;

j) balustrade and panels;

k) head guard and decking; and

m) safe and unobstructed access to entry and exit areas.

4.3.3 *Information for the Maintenance Organization*

The information relating to the tasks of the maintenance organization shall include the following:

4.3.3.1 The need to carry out the work of maintenance in conformity with the maintenance instructions and based on systematic maintenance checks.

After these checks, the maintenance organization shall decide in conformity with the maintenance instructions what is required to be done.

A list of typical examples of maintenance checks to maintain the installation is shown in Annex A.

NOTE — Due to the fact that the components can be different in design and operation, it is, therefore, not possible to give specific guidelines in this Standard.

4.3.3.2 The need to update the original maintenance instructions if the installation changes its intended use and/or the environmental conditions existing on the completion of the installation.

NOTE — The maintenance organization should be provided, by the owner of the installation, with the relevant maintenance instructions where modifications are carried out on the installation.

4.3.3.3 The need for the maintenance organization to ensure that a risk assessment for any working area and for any maintenance operation has been carried out taking into account the installer's maintenance instructions and all information supplied by the owner of the installation.

4.3.3.4 The need for the maintenance organization to inform the owner of the installation about any work to be carried out as a consequence of a risk assessment especially for the access and/or the environment related to the building installation.

4.3.3.5 The need to carry out a maintenance plan so that preventive maintenance is suitable for the installation and maintenance time is as short as reasonably practicable, without reducing the safety of persons, in order to minimize the non-operational time of the installation.

4.3.3.6 The need to adapt the plan for maintenance so as to take account of any predictable failures, for example, those due to misuse, mishandling, deterioration, etc.

4.3.3.7 The need to carry out maintenance operations by competent maintenance persons (*see* **3.3**) and provided with the necessary tools and equipment.

4.3.3.8 The need to maintain the competency of maintenance persons.

4.3.3.9 The need to carry out the maintenance periodically.

In determining the frequency of maintenance interventions, the following non-exhaustive list should be considered:

a) operating time and any non-operating periods of time;
b) age and condition of the installation;
c) location and type of building in which the installation is installed, as well as the needs of the users; and
d) local environment where the installation is situated, as well as external environmental elements, for example, weather conditions (rain, heat, cold, etc.) or vandalism.

4.3.3.10 The need to provide a 24 h, all year-round call-out service for rescue of persons.

4.3.3.11 The need to keep records of the result of each intervention due to a failure of the installation. These records shall include the type of failures in order to detect any repetition. They shall be available to the owner of the installation on request.

4.3.3.12 The need to put out of service the installation if the maintenance organization is aware of a dangerous situation, detected during the maintenance, which cannot be eliminated immediately, and to inform the owner of the installation of the need to keep it out of service until repaired.

4.3.3.13 The need to be organized to provide the necessary spare parts for any repair.

4.3.3.14 The possible need for attendance of a competent maintenance person(s), given reasonable notice, for any inspection carried out by an authorized third party or for building maintenance works to be carried out in the areas reserved for the maintenance organization.

4.3.3.15 The need to inform in due time the owner of the installation about necessary progressive upgrading of the installation.

4.3.3.16 The need to organize rescue operations, even with subcontractor(s), and to make provision for circumstances such as fire, panic, etc.

5 RISK ASSESSMENT

5.1 General

Before an installation is placed on the market, it is necessary that the installer/manufacturer carries out a risk assessment. Every risk shall be limited as much as reasonably possible by means of safety measures and suitable instructions. The instructions can never replace a safety measure which can be provided to reduce the risk.

It is necessary to determine the different intervention procedures of the maintenance operations and to determine the appropriate safety measures for each of these procedures.

The use of diagnostic systems may support fault finding, improve the maintainability of the installation and reduce the exposure of maintenance persons to hazards.

Safety in maintenance operations of the installation is ensured by adopting safety measures and providing instructions. Safety measures on the installation and in the building shall be provided by the installer and by the owner of the installation respectively.

For any working area, it is necessary to identify the list of the specific hazards related to health and safety and to carry out a risk assessment for any maintenance operation, including access to the working area.

For this purpose, the following should be taken into account:

a) presence of one or more maintenance persons in a working area;
b) foresee able actions of persons other than maintenance persons (for example, person switching on or off power circuits and dependent circuits or lighting circuits or trying to use the installation during maintenance operations, etc.); and
c) possible states of the installation (normal or abnormal due to a foreseeable failure of its component parts, external disturbances, disturbance of its power supply, etc.).

Annex B gives a list of examples of elements to be taken into account in any risk assessment for maintenance operations. However, several methods are available for the systematic assessment of risk.

5.2 Information for the Maintenance Organization

For safe maintenance and to provide relevant instructions, it is necessary, first of all, to identify the maintenance operations.

In particular, maintenance operations are:

a) those operations considered necessary for a correct and safe functioning of the installation and its components after the completion of the installation; and
b) those operations considered necessary during the "life" of some components, determining, as far as possible, the time or condition after which the functioning or the integrity of the component is not longer ensured even if correctly maintained.

In carrying out specific maintenance operations, if it is necessary to neutralize some safety functions (for example, an electric safety device), the hazard identification shall be taken into account for such a situation.

It is necessary to inform and warn the maintenance persons about: residual risks, that is, those for which risk reduction by design and safeguarding techniques are not-or not totally-effective.

Risks that arise from the necessary removal of certain guards to carry out specific maintenance operations.

The maintenance instructions and warnings shall prescribe the procedures and operating modes intended to overcome these risks and, if it is necessary, to specify personal protective equipment, instruments, tools and provisions to be used.

6 MARKINGS, SIGNS, PICTOGRAMS AND WRITTEN WARNINGS

If the risk assessment of the maintenance organization indicates that additional specific warnings are required for the purpose of maintenance, these shall be affixed directly on the installation/component or, when this is not possible, in the close vicinity.

Markings, signs, pictograms and written warnings shall be readily understandable and unambiguous. Readily understandable signs and pictograms shall be used in preference to written warnings.

Signs or written warnings carrying only "DANGER" shall not be used.

Information affixed directly on the installation/component shall be permanent and legible.

Any markings, signs, pictograms and written warnings affixed on the installation shall be renewed if they become illegible.

7 FORMAT OF THE MAINTENANCE INSTRUCTION HANDBOOK

7.1 The maintenance instruction handbook for any installation shall contain at the front at least the following:

a) type of installation, with its serial number, to which the instructions apply;
b) title of the handbook;
c) date of issue;
d) name and address of the installer/manufacturer;
e) name of the publisher, when different from the installer/manufacturer.

7.2 In the handbook:

a) all units used shall be SI units;
b) all pages shall be provided with a means to detect missing pages (numbers); and
c) all references to other documents shall be in full.

Warnings shall state the hazard, the related risks and the appropriate safety measure.

Type and size of print shall ensure the best possible legibility. Safety warnings and/or precautions shall be emphasized through the use of colours or symbols and/or large print. Where possible, signs shall comply with IS 16449 (Part 1) and IS 16451.

Documents giving instructions for maintenance shall be produced in durable form (that is, they shall be able to survive frequent handling) or triplicate copies shall be provided.

ANNEX A

(*Clause* 4.3.3.1)

TYPICAL EXAMPLES OF CHECKS TO BE TAKEN INTO ACCOUNT IN MAINTENANCE INSTRUCTIONS

i)	Controller	Check cabinet is clean, dry and free from dust
ii)	Gear box	Check gear and associated parts Check lubrication
iii)	Drive motor	Check bearings for wear Check lubrication
iv)	Brake	Check braking system Check parts for wear
v)	Auxiliary brake	Check braking system Check parts for wear
vi)	Intermediate gear box	Check gear and associated parts Check lubrication
vii)	Main drive chain	Check for tension and wear Check lubrication
viii)	Step/pallet chain	Check for tension and wear Check lubrication
ix)	Step/pallet	Check step/pallet and step/pallet wheels for integrity
x)	Conveyor belt	Check for condition and tension
xi)	Drive belt	Check for condition and tension
xii)	Clearances	Check step to step and step to skirting clearances.
xiii)	Combs	Check condition Check meshing with steps, pallets or belt
xiv)	Comb plate	Check clearances and operation
xv)	Handrails	Check for free running and condition Check tension Check synchronisation between step/pallet band and the handrail
xvi)	Track system	Check for condition and wear Check fixings
xvii)	Safety devices	Check operation
xviii)	Deflector devices	Check condition
xix)	Lighting	Check operation
xx)	Display	Check operation
xxi)	Signs/pictograms	Check condition
xxii)	Balustrade	Check condition of panels Check fixings of interior claddings

ANNEX B

(*Clause* 5.1)

EXAMPLES OF ELEMENTS TO BE TAKEN INTO ACCOUNT THE RISK ASSESSMENT FOR MAINTENANCE OPERATION

Elements	Machinery Spaces	On Step/Pallet band	Inside Step/Pallet band	Upper and Lowrer Landing	Control Cabinet	Machine Room (External drives)
Access and entry						
Inadequate lighting (including access)						
Falls/slips						
Falling on machine	■		■		■	■
Falling over balustrade	■		■		■	■
Contact with moving machinery						
Indirect contact with machinery						
Crushing and shearing (step t step or comb/step to skirting)				■	■	■
Gaps in balustrade	■		■	■	■	■
Intersection between floors and/or escalators	■		■	■	■	■
Persons on the step band	■		■		■	■
Safety switches and emergency stopping device(s)						
Inspection control						
Intersection between fixed and moving parts	■		■	■	■	■
Unintentional start/stop						
Machine moving (other than on power)						
More than one maintenance person working						
Manual operation		■				
Falling objects					■	
Unexpected water/dirt						
Contamination by oil and grease					■	
Dangerous substances						
Fire		■		■		
Missing step/pallet					■	■

□ Relevant ■ Not Relevant

ANNEX C

(*Foreword*)

COMMITTEE COMPOSITION

Lifts, Escalators and Moving Walks Sectional Committee, ETD 25

Organization	*Representative (s)*
Central Public Works Department (CPWD), New Delhi	Shri C. K. Varma (***Chairman***)
Airport Authority of India, New Delhi	Shri O. P. Chugh Shri Thomas Mathew T. (*Alternate*)
Central Electricity Authority, New Delhi	Shri Ashok Kumar Rajput
Central Public Works Department (CPWD), New Delhi	Shri Vimal Kumar Shri Rajiv Gupta (*Alternate*)
Delhi, Land and Finance Limited, Delhi	Shri Virender Kumar Sharma
Department of Delhi Fire Services, Govt of NCT of Delhi	Shri A. K. Sharma Dr G. C. Misra (*Alternate*)
Government of Assam, Chief Electrical Inspector, Guwahati	Shri Akhil Chandra Khataniar
Government of Tamil Nadu, Chief Electrical Inspectorate, Chennai	Shri G. Joseph Arockiadoss Shri P. Palani B. E. (*Alternate*)
Chief Electrical Inspectorate, Maharashtra	Shri Dinesh Khonde Shri Abhijeet L. Kasture (*Alternate*)
Chief Electrical Inspectorate, Energy and Petrochemical Department, Government of Gujarat	Shri Haiderali H. Khoja Shri Ashwin B. Chaudhary (*Alternate* I) Shri Prashant N. Gandhi (*Alternate* II)
Government of Karnataka, Chief Electrical Inspectorate, Bengaluru	Shri D. H. Basavaraju Shri Mohammad Javed Rabbani (*Alternate*)
Office of Chief Electrical Inspector, Department of Power and Non-Conventional Energy Sources, Government of West Bengal , Kolkata	Shri K. K. Dhara
Electrical Inspectorate, Labour Deptt, Govt of NCT of Delhi	Shri Mukesh Kumar Sharma Shri Jogender Singh (*Alternate*)
Delhi Metro Rail Corporation Limited	Shri Manuj Singhal Shri Kamal Ram Meena (*Alternate* I) Shri Sumit Kumar Sharma (*Alternate* II)
Electrical Contractors Association of Maharashtra, Pune	Shri Anil Gachke
Elevator and Escalator Component Manufacturers' Association of India, Chennai	Shri Suraj Thodimarath Shri Vikas Patil (*Alternate*)
Maharashtra Industrial Development Corporation (MIDC) Fire Service	Shri Santosh S. Warick Shri Milind V. Ogale (*Alternate*)
Fujitec India Pvt Ltd, Tamil Nadu	Shri S. P. Rao Shri R. Rajesh (*Alternate* I) Shri S. S. Balakrishnan (*Alternate* II)
Indian Electrical and Electronics Manufacturers Association, New Delhi	Ms Pragati Sohoni

Organization	*Representative (s)*
Johnson Lifts Pvt Limited, Chennai	SHRI T. SUBRAMANIAN SHRI V. KARTHIKEYAN (*Alternate* I) SHRI SACHIN MORE (*Alternate* II)
Kolkata Metro, Kolkata	SHRI D. C. RAY
Kone Elevator India Private Limited, Chennai	SHRI BALAJI K. SHRI U. VISWANATHAN (*Alternate* I) SHRI R. MANI (*Alternate* II)
Lerch Bates Private Limited, Mumbai	SHRI A. V. RAO
Mumbai Metro Rail Corporation Limited, Mumbai	DR VISHWAS AJNALKAR SHRI KUMAR ABHINAV (*Alternate*)
National Real Estate Development Council, New Delhi	BRIG R. R. SINGH
National Safety Council, Navi Mumbai	SHRI SUDHIR PATIL
Otis Elevator Company (India) Limited, Mumbai	SHRI ABHIJIT DANDEKAR SHRI SHRIHARI VISPUTE (*Alternate* I) SHRI MADHURENDRA SINGH (*Alternate* II)
Research Designs and Standards Organization (RDSO), Lucknow	SHRIMATI JYOTI BHASKAR SHRI JITENDER KUMAR (*Alternate*)
Schindler India Pvt Ltd, Mumbai	SHRI NIMISH DESHPANDE SHRI RAJAGOPALAN RENGANATHAN (*Alternate* I) SHRI RONNIE DANTE (*Alternate* II)
Shapoorji Pallonji And Company Private Limited, Mumbai	SHRI SHOEB ANSARI
Tak Consulting Private Limited, Mumbai	SHRI TAK MATHEWS SHRI WILLIAM REBELLO (*Alternate*)
The Indian Institute of Architects, Mumbai	SHRI VINAY M. PARELKAR SHRI PARESH KAPADIA (*Alternate*)
Thyssenkrupp Elevator India Pvt Ltd, Mumbai	SHRI VISHNU PARASHAR SHRI DEEPAK BALANI (*Alternate*)
Expert in Personal Capacity	SHRI P. M. TIPNIS
BIS Directorate General	SHRIMATI PRITI BHATNAGAR, SCIENTIST ‘F’ AND HEAD (ETD) [REPRESENTING DIRECTOR GENERAL (*Ex-officio*)]

Member Secretary

SHRIMATI MEGHNA MUDGAL
SCIENTIST ‘C’ (ETD), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Head (Publication & Sales), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: ETD 25 (18459).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: 601/A, Konnectus Tower-1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002	2323 7617
Eastern	: 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091	2367 0012 2320 9474
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg Chandigarh 160019	265 9930
Southern	: C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113	2254 1442 2254 1216
Western	: Plot No. E-9, Road No.-8, MIDC, Andheri (East), Mumbai 400093	2821 8093

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. CHANDIGARH. CHENNAI. COIMBATORE. DEHRADUN. DELHI. FARIDABAD. GHAZIABAD. GUWAHATI. HIMACHAL PRADESH. HUBLI. HYDERABAD. JAIPUR. JAMMU & KASHMIR. JAMSHEDPUR. KOCHI. KOLKATA. LUCKNOW. MADURAI. MUMBAI. NAGPUR. NOIDA. PANIPAT. PATNA. PUNE. RAIPUR. RAJKOT. SURAT. VISAKHAPATNAM.

Published by BIS, New Delhi